

Glass Fractures and Fragments

Glass fractures or fragments are often of value as evidence or leads in an investigation. Fractured glass found at a scene may show the direction from which a bullet entered a pane of glass. And it may show the angle from which the bullet was fired. Fractured glass may show the direction from which a blow was struck. Windowpanes broken outward, away from the inside of a room, may reveal the direction, force, and limits of an explosion. Window panes broken inward, toward the inside of a room, may suggest the means of an intruder's entry. And sometimes glass fragments bear chemical traces of inflammable agents.

Glass fragments also may yield clues to help identify suspects. If an intruder breaks a window, fragments of glass may stick to his clothing. They may fall into a trouser cuff. Or they may adhere to the soles and the sewn edges of his shoes. If glass is broken in a fleeing-the-scene vehicle accident, fragments of glass may be found stuck to or in the tires of a suspect's vehicle. Such fragments can be collected, analyzed, and compared to glass found on the scene.

Glass is normally a fused mixture of silica and two or more alkaline materials. The silica is often a natural sand. The alkaline materials are often soda, lime, or potash. The mixture also may have other elements and metals. These may be from impurities, or added for color, strength, heat-resistance, or other purposes. Glass is made by melting its elements in a crucible at very high temperature. The molten mass is then either rolled, blown, or molded into desired sizes and shapes. Later it may be polished, ground,

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or cut for useful or decorative purposes. Or like mirrors and safety glass, it may be combined with other materials for special purposes. Different amounts of ingredients used in batches of molten glass yield variations. These variations, when found and proven by the lab, may be of value as evidence.

The main determining factor of the evidence value of glass lies in the existence or lack of a physical fit between a questioned sample and a standard. This fit can make it possible to tell if the two fragments came from the same source. The physical properties of glass may also show the way in which a piece of glass was broken. Glass bends and stretches before breaking. It seldom breaks squarely across. Usually it leaves convex/concave edges or stress lines on the fractured edges. These breaks yield both radial and concentric fractures.

DETERMINING POINT OF IMPACT AND DIRECTION OF FORCE

Broken glass shows two kinds of fractures: primary, first-made fractures, and secondary, subsequent fractures. Primary fractures are radial. They look like the spokes

of a wheel as they radiate outward from the point of impact. Secondary fractures are concentric. They form a series of broken circles, or arcs, around the point of impact.

Radial fractures show up on the surface opposite to the one where the fracturing blow or pressure was applied. These fractures tend to lengthen after awhile because of internal stresses set up by the initial shock. The original radial fracture looks like a wavy line. Extensions to the original fracture run in a straight line. Temperature changes cause extensions to take place more quickly.

Concentric fractures are made by a force working in the opposite direction from that which made the radial fractures. The glass bends, then stretches and breaks on the same side as the first blow. Concentric fractures extend from one radial fracture to another.

WINDOW GLASS

Edges of broken pieces of window glass bear a number of curved lines, called ridge lines. These ridge lines are almost parallel to one side of the glass and perpendicular (at right angles) to the other. Ridge lines are often visible to the naked eye. If they are hard to see, the glass can be turned at angles to the light so the reflection will show the lines. Ridge lines show the increase in stress setup in the glass until it breaks.

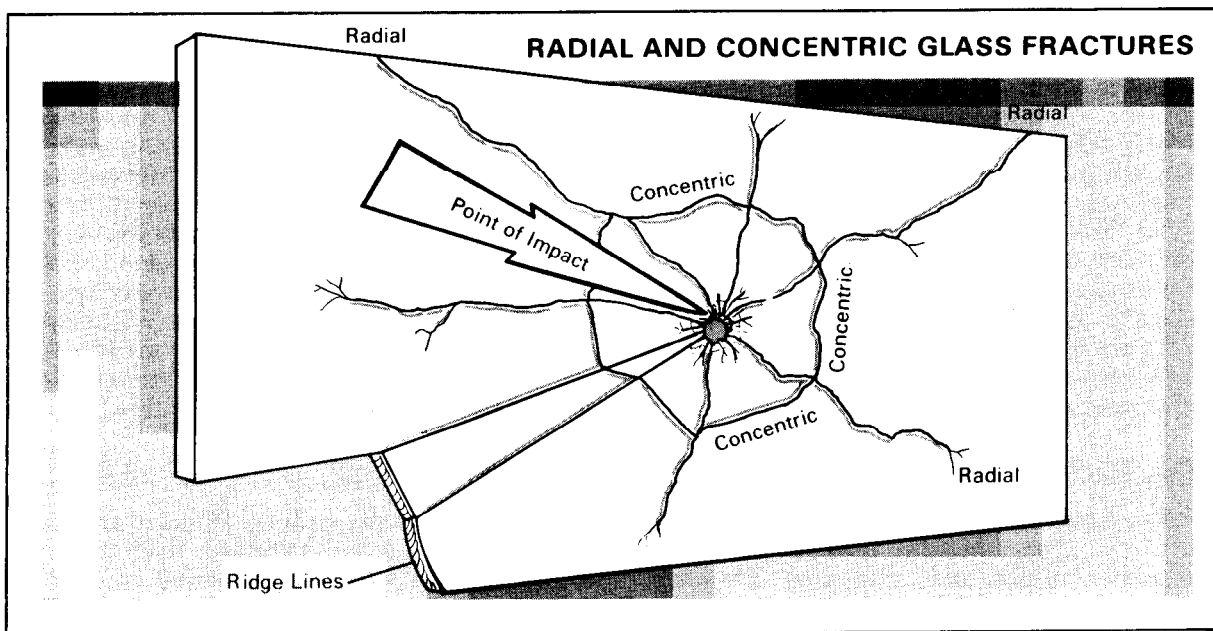
In radial fractures, the ridge lines are always perpendicular to the side opposite the impact. (The use of ridge lines to determine point of impact in concentric fractures is not

reliable.) Radial fractures follow the 4-R Rule. **Ridge** lines on **Radial** fractures are at **Right** angles to the **Rear** (side opposite the impact). This rule is valid only from point of impact to the first concentric fracture and valid only to the first bend in the glass. You must find the point of impact to be able to find the direction of force.

The direction of a blow is rarely found by checking a single piece of broken glass. If you must show the way a pane of glass broke, you need enough pieces to find which are the radial edges. Finding the outside and inside of the glass may be helped by examining the glass surface. The amount of dirt, putty marks, and other clues may help you mentally place the pane in its original form.

WINDSHIELD GLASS

Determining the point of impact and direction of force is more difficult in windshield glass. Windshield, or safety glass, is made with a transparent binding agent like vinyl plastic sandwiched between two sheets of plain glass. The binding agent halts the shattering of the glass when it is struck. Due to the structure of safety glass, cracking is often incomplete. Neither the radial nor the concentric cracks go all the way through from one side to the other. If concentric cracks and no radial cracks are on one side this is the side



of impact. If only radial and no concentric cracks are found on one side, this is the side away from the impact. The cracked side may be found by sliding a fingernail or sharp-pointed instrument along the glass surface across the apparent cracks.

A lab expert can also test for the side of impact based on the property of safety glass. Safety will bend, and remain bent, instead of shattering when struck. The bending will cleave in a concave surface on the impact side and a convex surface on the other.

COLLECTING AND HANDLING

Glass and glass fragments are collected much like other types of evidence. Differences are due to the nature of the glass itself and to the information you are seeking. *Glass and glass fragments must be photographed and located on your crime scene sketch before they are touched or moved.* Their obvious or suspected relation to the case must be noted. When you collect fragments, avoid smudging prints or disturbing dust, dirt, bloodstains, or other foreign matter which may be on the glass. These may provide leads or be evidence in themselves. Wear rubber or fabric gloves. Use rubber-tipped tweezers or something like them to handle small fragments. This will keep the glass from being scratched. Metal tweezers with adhesive tape over the inner surface of the points work well.

Pick up the glass by the edges and avoid the flat surface as much as you can. Collect as many fragments as you can to make reassembly as complete as possible. Collect and preserve particles too small to match or reconstruct. The lab can analyze these for their physical properties.

Sometimes, when glass is broken out of a window or door, pieces remain in the frame. Remove the frame and keep it intact, if you can. This will help in the reassembly of the broken pieces. If this cannot be done, the pieces left in the frame should be carefully marked. Show both inside and outside surfaces. Take them out to avoid further damage to the glass or disturbing anything thereon. If the frame is not removed, samples of the wood, paint, putty and any other materials should be taken from it.

MARKING

Mark glass fragments with a diamond point or Carborundum pencil. A piece of properly marked adhesive tape or a grease pencil will also work. Include your initials, the date, and the time. *Place marks where there is no deposit of value as evidence.* Place marks on the side which was up (or inside if taken from a window frame or door) when

found. This helps in the reassembly of fragments and in the reconstruction of the incident. Include a sequence number which, when keyed with your notes, photographs, and sketches, will identify where the fragments were found. Place fragments too small for markings in containers. Mark both the container and lid.

PRESERVING

Wrap glass or glass fragments in soft paper, cotton, or like material so they don't break. Do this in a way to avoid damage to prints or other substance to be sent to the lab or saved as evidence. Put the wrapped glass in containers and fasten the containers so that the glass will not shift. Wrappings and containers should be marked "Fragile." Evidence which you decide should be

examined by the lab must be packed carefully. Friction, shifting, or contact with other items can destroy or contaminate the evidence.

Submit all pieces and fragments pertaining to an incident at the same time. Identify each piece of evidence clearly on separately wrapped items.

EVALUATING

Glass fragments and fractures are evaluated like other items of evidence. You consider their value alone and also in

relation to all other evidence. Your evaluation begins as evidence is collected, and it continues until the case is closed.

Early in your evaluation, consider the need for scientific lab analysis. Glass is not destroyed or appreciably altered in lab work except in spectrographic examination of small fragments. Thus, the evidence pieces can be used later to compare with suspect pieces, if they are needed. If lab examination is needed, *request it as soon as you can*. Speed may be essential to halt the loss of odors or residue.

Early submission for lab analysis may help your case. For example, the lab

specialists may, if enough glass from a vehicle is found, learn the vehicle's make, model, and year. They may also eliminate the possibility that the glass came from a suspect vehicle, thus thinning the field. But sometimes you may want to delay sending some items to the lab. Keeping pieces of a broken headlight lets you match it to remaining pieces found on a suspect's vehicle. This can be confirmed later by lab analysis.

RECONSTRUCTING FRACTURED GLASS

Only the lab can truly reconstruct a piece of fractured glass. But you may want to put pieces of glass in relation to one another to get a better look at the fractures. How you do this will depend on the size and shape of the object. Do not do this on a permanent basis. Pieces or fragments are *not* sent to the lab in a reconstructed form. Damage may occur in handling or transit.

You must take care not to rub the fractured edges against each other. You may cause more flaking or fracturing and destroy parts of the ridge line marking. One way to avoid this is to keep the edges at least a pencil point's width apart. When as many pieces as possible are in place, the outlines may then be traced on the paper. Make notes on the paper to fit your markings on the pieces for future reference and use. If you need a more permanent reconstruction later, the pieces may be fixed to a base of plywood or heavy cardboard with plastic tape or glue.

To reconstruct a curved or irregular-shaped piece, like a bottle or jar, is more difficult. You must find out both the size and the shape of the object. Some pieces (such as automobile headlight lenses) may have patterns cast or cut into them. These you can compare and match more easily than you can smooth glass surfaces. In many cases, the pattern may be matched independently of the fractured edges. But the exact matching of edges is still the most conclusive evidence of common source.

Prepare by first finding out the circumference and the curvature of the spherical surface. If you have enough pieces,

or if class marks can be found, you may show the object as to make, type, size, and so forth. This will permit getting a duplicate, and the problem is made easy.

Lab specialists can reconstruct curved glass by forming a cast the size and shape of the inside surface. They use linseed oil putty or a like material that will keep its elasticity. If the lens can be identified, a plaster cast may be made from a duplicate. The fractured pieces can be mounted on it, and held in place by plastic tape. Pieces and fragments, properly marked, can then be matched by their edges and pattern markings, placed on the cast, and pressed in just enough to hold them in place.

If lab specialists do not have enough pieces to identify the object or show the circumference and spherical surface, they take a piece with enough arcs to make rough measurements to allow forming a putty cast. They can use a spherometer or a Geneva gage to tell both curvature and circumference. They also may get close measurements by geometrical projection. Using the arcs of the circumference and sphere of the found fragments, they trace the arc of a fragment on a piece of paper. Then they use standard geometrical construction to approximate the diameter. The circumference can then be projected.

Keep in mind that these are only rough approximations. Lenses are made not only in round, but also in oval and other shapes. And spherical surfaces are not always completely regular in contour.

EXAMINING FRACTURES IN THE FIELD

In the field you must be able to distinguish fractures caused by heat from those caused by blunt force. And you must be able to distinguish both of these kinds of fractures from that created by high-speed impact like that of a bullet.

BULLET HOLE FRACTURES

Checking glass for bullet holes may provide useful knowledge. It may be possible to determine the direction from which a bullet was fired. Sometimes the sequence of a series of bullet holes can be learned. And sometimes the type of ammunition used and the distance from which the bullet was fired may also be learned.

The direction from which a single bullet enters a piece of glass, whether window, plate, or safety, is often seen with ease. A bullet makes a somewhat *clean-cut* hole in the side of entrance. As it penetrates, it pushes glass fragments ahead of it. This causes a saucer-shaped or coning depression on the exit side, with a greater diameter than the entrance hole. Determining direction becomes more difficult when several bullets enter safety glass closely together. The last bullets enter a glass surface which already has a number of cracks. As a result, small pieces are knocked out around the holes on both sides. However, broken edges on the entrance side are almost perpendicular to the surface of the glass. On the exit side these edges are at an angle to the surface.

Sometimes it is important to know which of two or more bullet holes in a pane of glass was made first. You may be able to determine this from the fractures. When a fracture traveling across glass meets a fracture that is already present, the newer fracture will be stopped. If fractures from one bullet hole are stopped by those of another, you may conclude that the blocking fracture was made first.

The angle from which a bullet enters a piece of glass may be found by the amount of chipping at the exit crater. If a bullet strikes glass straight-on, chipping around the exit hole will be fairly even. If a bullet enters from

the right of the glass, very little chipping will be found on the right side of the exit hole. Instead, there will be a lot of chipping around the left side of the exit hole. And the entrance hole will show straight and short radial fractures on the right, while one or two long radial fractures should appear on the left. If a bullet enters from the left of the glass, these fractures will be reversed.

To learn the angle from which a bullet was fired, the bullet hole should be compared with test shots fired from varied known angles. The test shots should be fired through the same type of glass and under the same conditions with the same type weapon and ammunition as the original bullet hole.

Ammunition type can sometimes be learned from the size and features of the bullet hole. Bullet holes in safety glass offer more evidence than those in window glass, because safety glass fragments do not fall. When a bullet goes through a pane of glass in a sidewise fashion, it is often hard to show the caliber of the bullet. The lab can sometimes estimate the caliber and type of weapon used. Coordinate with the lab to learn the best way to submit your evidence for this test.

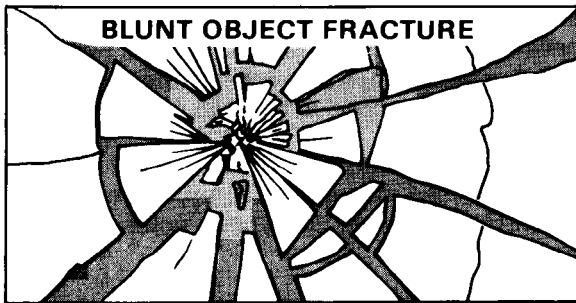
Determining the distance from which a bullet was fired depends on knowledge of the ammunition used. A high speed projectile fired from afar may yield a fracture like one from a slower projectile fired at closer range. If a bullet has been fired from a long distance, most of its velocity is spent before it reaches the pane of glass. It will break the pane in much the same way as will a stone. A shot at close range with a weapon with great muzzle blast will give like results. The blast itself breaks the glass but may leave powder residue and cause a crystallizing (frothing) of the glass.

BLUNT OBJECT FRACTURES

Glass fractures caused by a blunt object will show a pattern of fractures like, but not as regular as, the pattern from a bullet. This difference is mainly due to the impacting force being dispersed over a greater area.

It may be harder to tell the side from which the impact came. But you can still tell by the ridge lines on the edges of the radial fractures.

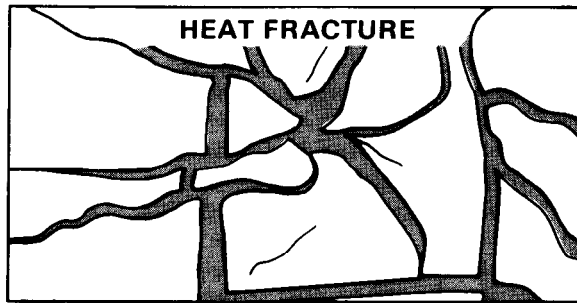
First, partly reconstruct the object to find the radial and concentric fractures. Then look at the radial fracture lines. The ridge lines on the side opposite the impact will be well-developed and distinctly individual. The ridge lines on the front, or impact side, will be much less so. They tend to run together here and lose their individuality. The 4-R Rule still applies. Because glass bends away from the side of impact, the first (radial) fracture occurs on the rear side after the limit of elasticity has been reached. This causes the distinct ridge lines on the stretching (rear) edge of the radial fractures. At the same time, some grinding action takes place on the front side. This causes some chipping and flaking of the edge and partial obliteration of the ridge lines.



HEAT FRACTURES

Recognizing heat fractures in glass can help you eliminate areas of concern in your investigation. Fractures due to heat are *wave-shaped*. They do not show a regular pattern of radial and concentric lines like fractures caused by impact. Heat fractures also show little, if any, curve patterns (stress lines) along the edges. Expansion of the glass (stretching action) occurs first on the side exposed to the heat. Glass splinters will often fall toward that side. Reconstruction of a glass object fractured by heat will show the wave-shaped fracture pattern.

If the ridge lines are smooth, or almost so, and no point of impact is found, and you have considered other factors like the circumstances under which the fragments were found and their location, you may conclude that the fracture was due to excessive heat.



EXAMINING FRAGMENTS AND FRACTURES IN THE LAB

Glass fragments and fractures may yield important leads when examined by trained technicians. The lab can analyze glass fragments and fractures by a variety of means. A scientific examination of glass particles may show matching physical and chemical features. This could prove whether the particles did or did not come from the same piece of glass. It can show if minute particles that look like glass are actually glass. Examination of fractured glass may tell not only the type of glass, but the manufacturer. The manufacturer's name or logo may be imprinted or molded in the glass. Examination may show the direction of a

blow and the direction and angle of impact. It may also show the sequence of holes.

Glass on vehicles often bears traces of the paint used on the vehicle body. Such traces can be of value, especially in cases of fleeing-the-scene accidents, because they may show the color of the vehicle. While these traces may be plainly visible to you, better results can be obtained by USACIL. Examine glass in such cases with great care. You do not want to disturb *any* specks, flakes, chips of paint, or other foreign matter on the glass. And be sure to make specific reference to them in your request for lab examination.